2. On some Points in the Structure of *Galidia elegans*, and on the Postcaval Vein in Carnivores. By Frank E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 123–131.)

The death of a specimen of this Madagascar Viverrid on February 21 last has enabled me to supplement my account of *Galidictis striata** with some notes upon its ally *Galidia elegans*, of the anatomy of which there is at present but little knowledge. The two genera are undoubtedly very closely allied, but nevertheless there are some differences which fully justify the generic separation of the two, and which include facts of some little interest as a contribution to the anatomy of the Viverridæ. I have endeavoured to examine into all the matters which are known to be of importance from a systematic point of view, and the excellent condition of the specimen fortunately permitted a careful study of some of the veins.

§ *External Characters.*

The external characters of *Galidia* are for the most part known and are referred to by Mivart in his account of the genera of Æluroidea †. He observes that "the anus does not seem to open into any cutaneous depression." I find that this statement, made perhaps somewhat tentatively ‡, is perfectly correct. I also agree with Mivart in finding no prescrotal glands.

Carpal vibrissæ are present, as in so many other Carnivora §.

It will be noted that the absence of prescrotal glands differentiates the genus *Galidia* from *Galidictis*, in which they are present, but that both agree in the absence of a cutaneous pouch into which the anus opens. The anus is large in *Galidia*, as is also the case with *Galidictis*.

§ *Alimentary Canal.*

In my paper upon *Galidictis* I have recorded the fact that in a skull of *Galidia elegans* examined by me the first premolar was present on both sides, there being thus—so far as this specimen was concerned—no difference from the allied *Hemigalidia*. I find, however, from an examination of the example of *Galidia elegans* which forms the subject of the present communication to the Society, that the tooth in question is absent, and from both

* "On some Points in the Structure of *Galidictis striata*," P. Z. S. 1907, p. 803.

† "On the Classification and Distribution of the Æluroidea," P. Z. S. 1882, p. 135.

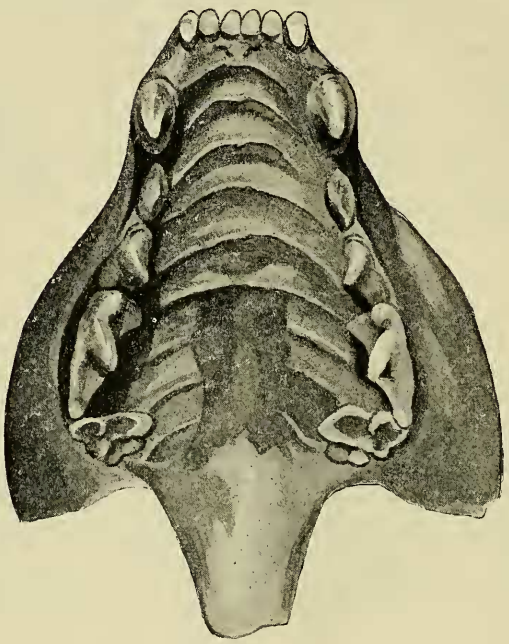
‡ It is queried in the definition of the subfamily *Galidictinæ*, *loc. cit.* p. 189.

§ Beddard, "Observations upon the Carpal Vibrissæ in Mammals," P. Z. S. 1902, vol. i. p. 127.

sides of the jaw. The species therefore obviously varies in this peculiarity. There is, moreover, a considerable diastema between the canine and pm. 2, so that a small pm. 1 which has not emerged may be present in the jaw.

The *ridges of the palate* in *Galidia elegans* are reproduced in the accompanying figure (text-fig. 123). There are six complete semicircular ridges perfectly symmetrical, of which the first is not so extensive laterally as the rest. This runs across between the

Text-fig. 123.



Palate of *Galidia elegans*.

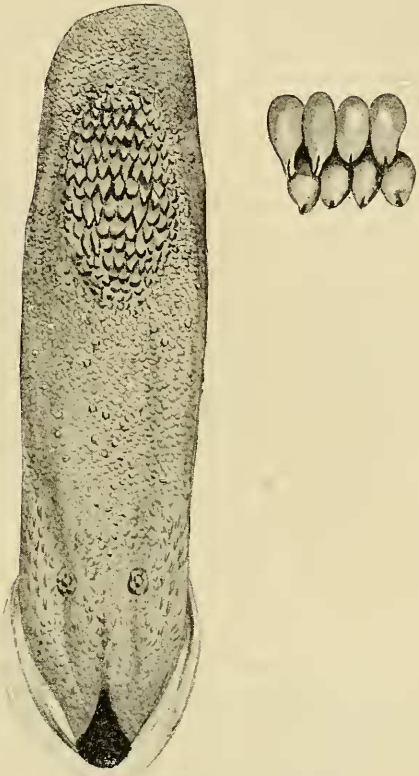
two canines. The next ridge corresponds to the diastema, and the remaining four to the three premolars. Thereafter follow four half-ridges on each side, but the details will be best understood by a reference to the figure referred to.

The *tongue* has been already partly described by Mivart*, who has recorded a well-defined patch of spiny papillæ upon the middle of the anterior half of that organ. This, as I have already pointed out, is exactly what is to be found in *Galidictis*. There is, however, no further description of that organ, which I show in the accompanying drawing (text-fig. 124).

* P. Z. S. 1882, p. 498.

The *papillæ circumvallatæ*, as shown in that drawing, are only two, right and left, as in *Nandinia*, the Genet, *Hyæna striata*, *Proteles* *, three or even more (*Arctictis*) being met with in other Viverridæ. There is nothing remarkable in the size or shape of these papillæ.

Text-fig. 124.



Tongue of *Galidia elegans*, dorsal view.

On the right are eight of the strong anterior papillæ more highly magnified.

The *fungiform papillæ* are scattered over the dorsum of the tongue between the papillæ circumvallatæ and the anterior patch of strong papillæ; they are chiefly massed in the actual middle line of the tongue, and there is no narrow middle line free from them as in the Civet. The arrangement of these papillæ seems,

* *Loc. cit.* p. 500. I can confirm Dr. Mivart in the case of *Hyæna striata*, where there are distinctly only two of these papillæ.

in fact, to be very like that of *Nandinia*. The anterior patch of conical papillæ is like that of *Galidictis*, which has been figured by myself *, and of about the same extent. A few of the papillæ are shown more highly magnified at the side. Their tips show a tendency to become bifid and to be separated from the rest of the papillæ. In these characters they are not unlike the conical papillæ of *Galidictis*.

The *frænum* of the tongue has a free fold of mucous membrane near its attachment to the floor of the mouth; but this fold does not form a continuous fold anteriorly, but is prolonged into two elongated processes on either side of the frænum, apparently differing from the Genet †.

The *stomach* seems to me to be as described by Dr. Mivart ‡, and I have nothing to add to his remarks.

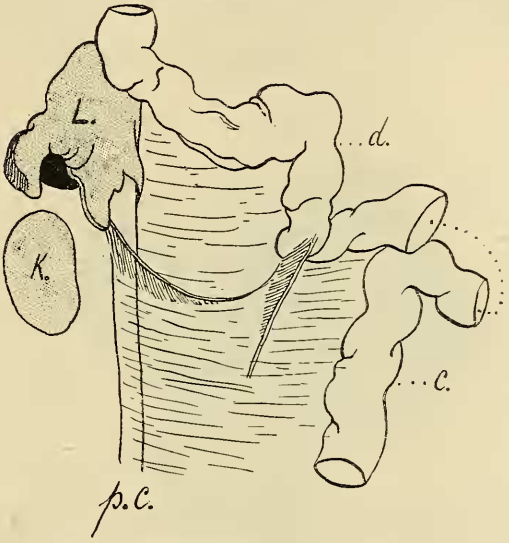
The *intestinal tract* is quite typically Carnivorous, but there are various details of structure to which it is necessary to refer in comparing *Galidia elegans* with its allies, and especially with *Galidictis*. The duodenum forms the usual **C**-shaped loop enclosing a part of the pancreas, from the end of which (where the pancreas bends up towards the liver parallel with the portal vein) arises the ligamentum recto-duodenale as in other Carnivora. This ligament has a curious relation to the hepato-caval ligament, which, if it be more general than I suppose, is at least not universal. The latter ligament, arising from the inner edge of the caudate lobe of the liver, is attached as usual to the postcaval vein, but a considerable portion of it strays on to the mesocolon and becomes continuous with the recto-duodenal ligament, the two forming together a semicircular fold of watch-pocket form (see text-fig. 125). I found the same arrangement to be much more marked and symmetrical in *Nandinia binotata*. At the opposite extreme is *Procyon lotor*, in which the short ligamentum hepato-cavale is attached only to the postcaval vein.

As is the case with other terrestrial Carnivora, the *colon* and *rectum* form a very short tube, which is perfectly straight in *Galidia*. It is decidedly shorter than in *Galidictis*, where I have described a rudimentary transverse colon, and where, if the colon were straightened out, it would reach forward as far as the diaphragm. In *Galidia* the colon lies perfectly straight, and only reaches up to the anterior end of the left kidney, at which point the cæcum arises. The total length of the colo-rectum is $4\frac{3}{4}$ inches, something short, therefore, of that of *Galidictis*. I have made notes on the form of the colon in a number of Viverrids, which I may here compare with that tube in *Galidia* and *Galidictis*. In *Crossarchus fasciatus* there is as well a developed transverse colon as in *Galidictis*. *Suricata tetradactyla* agrees with the two last-mentioned Æluroids. If the colon were fully straightened out, the cæcum would be seen to arise a long way in front of the left

* P. Z. S. 1907, p. 806, text-fig. 210.
† Mivart, P. Z. S. 1882, p. 499, fig. 3 B.
‡ P. Z. S. 1882, *loc. cit.*

kidney. The species *Herpestes smithii* shows the same bending of the colon over to the right side of the body. On the other hand, in *Paradoxurus hermaphroditus* the colon is short and quite straight, and there is no trace of a transverse colon, such as exists in the types already referred to. The cæcum of this animal, in fact, lies pretty well in the middle of the body. In the closely-allied *Paradoxurus niger* the conditions are the same, and the cæcum originates only just in front of the left kidney. *Viverra civetta* is also quite like *Paradoxurus*. *Genetta rubiginosa* has this

Text-fig. 125.



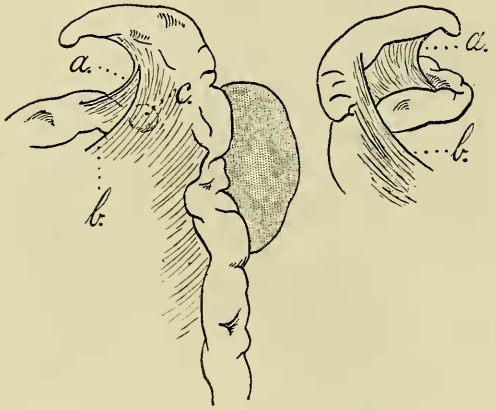
Caudate lobe of liver, duodenum, and adjacent structures in *Galidia elegans*.

c. Colon. *d*. Duodenum, from which arises recto-duodenal ligament partly inserted upon mesocolon and partly continuous with hepato-caval ligament as explained in text. *K*. Right kidney. *L*. Caudate lobe of liver, from the lowermost process of which arises hepato-caval ligament. *p.c*. Postcaval vein.

peculiarity exaggerated, for the cæcum arises from the colon considerably behind the left kidney. While, therefore, these facts seem to justify the separation of Viverrines and Herpestines among the Viverridæ, they leave the affinities of the alleged subfamily *Galidictinæ* doubtful; and it is remarkable that while *Galidictis* is Viverrine in its scent-glands, it is Herpestine in its colon, while, on the other hand, *Galidia* is Herpestine in the absence of scent-glands and Viverrine in the condition of the colon, which is perhaps what is to be expected in a subfamily

believed to be an ancient Viverrid assemblage. The relationship of the colon to the left kidney is shown in the accompanying figure (text-fig. 126). That drawing also illustrates the cæcum shown from both sides. It is necessary to exhibit the cæcum on both sides because of the differences in the cæco-colic ligaments on the two sides of the cæcum. The cæcum itself, independently of its mesenteries, has been already figured by Dr. Mivart *, and quite correctly except that it is represented as straighter than it is in nature. This is, however, to be accounted for by the cutting of the various ligaments which attach the cæcum to adjoining regions of the gut. It is clear, however, from this figure that *Galidia* agrees with *Galidictis* † in possessing a long and thus Herpestine cæcum. In my figure of the cæcum of *Galidictis* I

Text-fig. 126.



Cæcum and adjacent structures of *Galidia elegans* viewed from both sides.

The left-hand figure shows the position of the cæcum with regard to the kidney, which is partly covered by the colon.

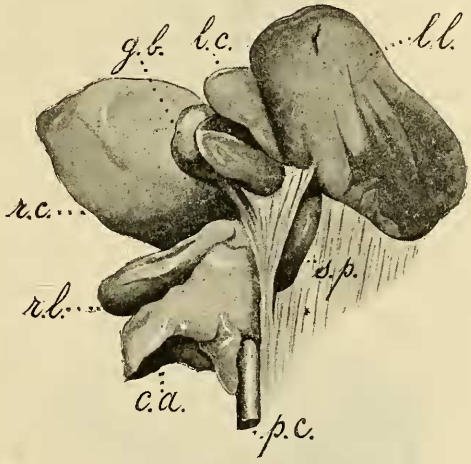
a. Median frænum of cæcum. *b*. Lateral cæco-colic ligaments.
c. Lymphatic gland.

have contrasted this Viverrid with *Herpestes fulvescens*, in which latter the frænum of the cæcum—the anangious ligament binding it to the ileum—is continuous up to the very top of the cæcum. In *Galidictis* this is not the case, and the actual tip of the cæcum is not thus attached; the frænum does not run so far. *Galidia* agrees entirely in this particular with *Galidictis*. I may take this opportunity of mentioning that *Suricata tetradactyla* does not agree in this full extension of the ligament to the very tip of the cæcum with *Herpestes*. I also pointed out in the paper referred to that in addition to the median anangious frænum the cæcum

* P. Z. S. 1882, p. 508, fig. 8 C. † P. Z. S. 1907, p. 805, text-fig. 211.

of these animals is fixed to the gut by two minute lateral ligaments which bear blood-vessels. These were particularly obvious in the example of *Galidia elegans* which I have dissected, since they were loaded with fat. It is noteworthy that the median membrane being anangious had not received a coating of fat. These membranes, one on the left and one on the right side, are almost microscopic, as is shown in my drawing of *Galidictis* *. *Galidia elegans* shows an interesting difference, for in that Carnivore the membrane on the right side is very much larger than that on the left, and joins the median anangious frænum. The figure (text-fig. 126) also shows a lymphatic gland imbedded in the right-hand lateral mesentery, the presence of which appears to be very typical in these Carnivora. I have already referred to its existence in *Galidictis striata* and *Genetta vulgaris*. I have also found it in *Suricata*. The left-hand mesentery is quite small.

Text-fig. 127.



Liver of *Galidia elegans*, abdominal surface.

c.a. Caudate lobe. *g.b.* Gall-bladder. *l.c.* Left central lobe. *l.l.* Left lateral lobe. *p.c.* Postcaval vein. *r.c.* Right central lobe. *r.l.* Right lateral lobe. *s.p.* Spigelian lobe.

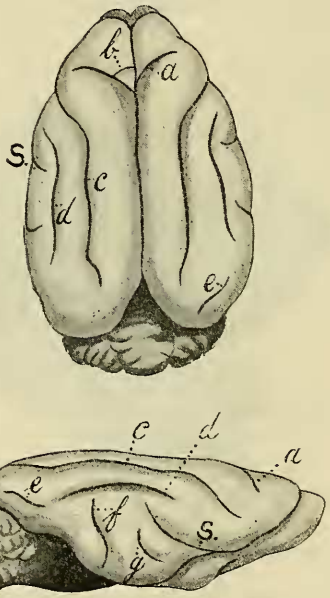
The *pancreas* has the usual form of the figure 6 so general in Carnivora. The circular portion of the gland lies within the duodenal loop. The *liver* is represented from the abdominal surface in the accompanying text-figure (text-fig. 127). It does not differ greatly from that of *Galidictis* †, with which it may be compared.

* P. Z. S. 1907, p. 808, text-fig. 211 B.
† P Z. S. 1907 p. 809, text-fig. 212.

§ *Brain.*

I figure the brain of *Galidia elegans* in two aspects (text-fig. 128), from the dorsal side and a lateral view, which together expose all the fissures at any rate of one side. There is, however, no great asymmetry in the brain of this Viverrine such as demands the additional representation in the figure of the left side. On the whole, the brain agrees very closely with that of *Galidictis* *, which I have already figured and described at some length, comparing it with the brain of allied forms. Viewed from above, the general outline of the brain does not present any marked differences from that of *Galidictis*, and it is of about the same size.

Text-fig. 128.



Brain of *Galidia elegans*, dorsal view and lateral view.

a. Crucial sulcus. *b*. Precrucial sulcus. *c*. Lateral sulcus. *d*. Suprasylvian. *e*. ? Ectolateral sulcus. *f*, *g*. Ectosylvian fissures (see text). *S*. Sylvian.

The *crucial* sulcus is long, as it is in *Galidictis* (where I have contrasted its length with the shortness of the same fissure in *Viverra civetta*), and is also slightly asymmetrical in relation to its fellow. The right-hand sulcus is a little in advance of the left. It is curious that while the same furrows in *Galidictis* are also

* P. Z. S. 1907, p. 814, text-fig. 216.

slightly asymmetrical, the asymmetry is precisely the reverse. In this region the brain of *Galidia* shows an interesting feature not shown in the brain of its ally *Galidictis*. On the left side of the brain, and on the left only, as is shown in the text-figure, there is what certainly appears to be a precrucial sulcus, such as is figured by Dr. Elliot Smith in *Viverra* *, and is well known to be very characteristic of the Arctoid division of the Carnivora †.

The *lateral* sulcus seems to be in all probability a conjoined lateral and coronary sulcus, as I have given reasons for believing to be the case with the lateral sulcus of *Galidictis*. There is no great difference between these fissures in the two Carnivores now under consideration. Posteriorly in *Galidia* the sulcus bends inwards and then outwards, ending therefore in a semicircular outline. It may well be that this is an indication of a vestige of an ento-lateral sulcus such as is figured by Elliot Smith in *Herpestes pulverulentus* ‡.

There is, moreover, just a faint indication of an anterior prolongation to the inside of the lateral sulcus from the angle which the latter makes when it bends outwards. I could find no definite ansate sulcus in the brain of *Galidia*.

The *suprasylvian* sulcus ends posteriorly at the level of the inward bending of the lateral fissure. Anteriorly also it does not extend so far as does the lateral fissure, in both these points differing from *Galidictis* and from *Herpestes* as figured by Elliot Smith.

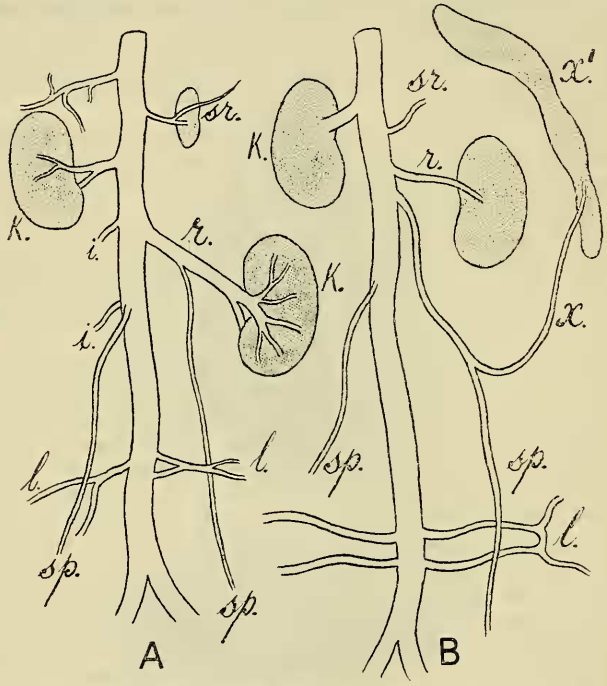
The *sylvian* complex of fissures differed slightly on the two sides of the body. The right side is represented in the annexed figure (text-fig. 128). The fissure which I have lettered "*f*" seems to me to correspond with the postsylvian fissure of *Herpestes*, in which case perhaps "*S*" is not really the sylvian fissure proper, but an anterior ectosylvian, while "*g*" is a posterior ectosylvian. On the other hand, on the left side of the brain, while *S* retains the same position and relations, the two fissures "*f*" and "*g*" form only one fissure, the lower part of "*f*" being absent, and the upper part joining, or very nearly joining, "*g*." The arrangement here is, in fact, very like that of the left side of the brain of *Galidictis* figured by myself. There is in favour of the former interpretation of the furrows in question the fact that the furrow which I have lettered "*S*" does not reach the rhinal furrow at quite the right point of a true sylvian fissure. This, I think, will be apparent after an inspection of my drawing. It seems, on the whole, to be the most reasonable course to regard the true sylvian fissure as not present, but to consider the fissure which I have lettered *S* to correspond to the similarly-lettered furrow in Dr. Elliot Smith's figure of the Hyæna's brain §, which he refers to in the text as "the so-called 'Sylvian fissure,'" and which is followed by two fissures in the temporal region, as in *Galidia*.

* Cat. Mus. Roy. Coll. Surgeons, vol. ii. ed. 2, 1902, p. 249, fig. 122.
† Mivart, Journ. Linn. Soc., Zool. vol. xix. 1886.
‡ *Loc. cit.* p. 254, fig. 625. § *Loc. cit.* p. 257, fig. 130.

§ *The Postcaval Vein and its Branches in* Galidia *and in some other Carnivora.*

These veins (text-fig. 129 A) in the specimen of *Galidia* which I dissected were turgid with blood, and therefore in a very favourable condition for anatomical study. I take this opportunity of comparing them with those of other Carnivora which I have dissected lately. The large postcaval vein is quite normal in position—that is, it lies to the right of the aorta as in the majority

Text-fig. 129.



Postcaval vein and branches in *Galidia elegans* (A) and *Nandinia binotata* (B).

i. Intercostal veins. *l*. Lumbar veins. *K*. Kidneys. *r*. Renal veins. *sp*. Spermatic or ovarian veins. *sr*. Suprarenal veins. *x*. Splenic branch of ovarian. *x'*. Spleen.

of mammals. The renal veins are asymmetrical, that of the right kidney entering the postcaval above the entrance of the left renal. This asymmetry is, it will be perceived, the exact reverse of that of *Galidictis**, where the left renal enters the postcaval higher

* P. Z. S. 1907, p. 811, text-fig. 213.

up than the right. Each renal vein, when close to the kidney, divides into two branches, one lying above the other, which supply respectively the dorsal and ventral side of each kidney, over the surface of which they ramify, as is so usually the case among the Æluroidea. This difference of symmetry in the renal vein is correlated with the fact that in *Galidia* the left suprarenal flows into the postcaval independently of the left renal, whereas they join in *Galidictis*. Furthermore, there are no additional renal veins such as are present in *Galidictis*. The spermatic veins arise as in *Galidictis* (and indeed most mammals), the left from the left renal, the right from the postcaval vein considerably below the entrance into the latter of the renal veins. Two intercostal veins flow into the dorsal surface of the postcaval between the left renal and the right spermatic vein, each of them, however, very nearly corresponding in the point of entrance to the point of entrance of those two veins. The postcaval receives lower down two lumbar veins on each side, as in *Galidictis*. The exact disposition of these veins in *Galidia elegans* is as follows:—On the left side there are two veins, each of considerable width, which lie respectively above and below the corresponding artery, which therefore emerges from the aorta between them; before passing respectively anteriorly and posteriorly the two veins are joined by a bridge which passes over the artery just before it divides. On the right side the two lumbar veins unite just before opening into the postcaval, and they are not united by a bridge distally.

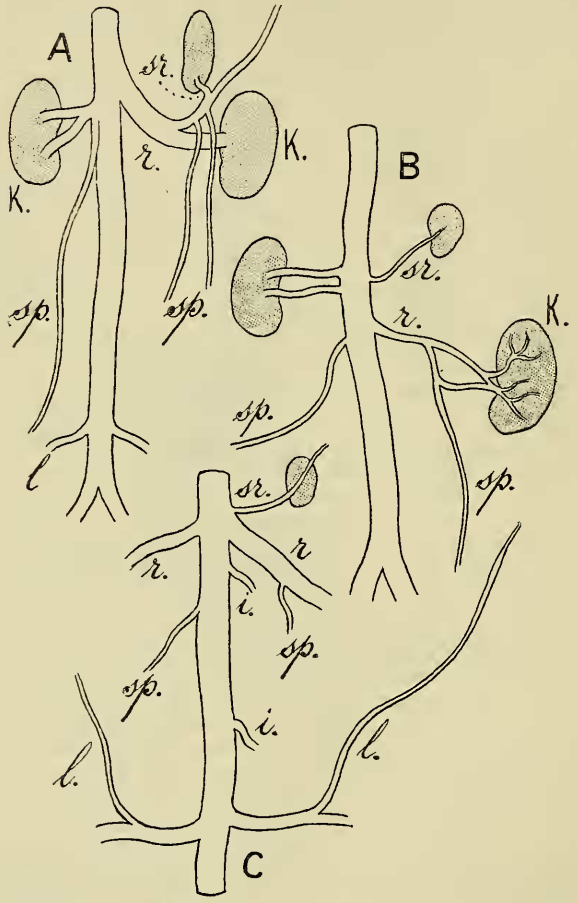
In an example (text-fig. 130 B, p. 488) of *Suricata tetradactyla* I found a closer agreement with *Galidictis* than with *Galidia*. There were two renal veins on each side, arising and ending precisely as I have figured them in *Galidictis*. The right ovarian vein, though pouring its contents into the postcaval itself as in most other Carnivora, reached that vein rather nearer to the left renal than in either *Galidictis* or *Galidia*.

In another example of *Suricata* (text-fig. 130 A) the conditions were in many points the same, but in others a little different. On the right side the renal veins were two, though ultimately reaching the postcaval by a common trunk. The renal was single on the left side, and this vein was more symmetrical with its fellows of the right side than in the first specimen. There was in this specimen an unusual origin of the left ovarian vein. The right was as in the last specimen. The suprarenal of the left side was, as often in Carnivores, an important parietal vein to begin with, of which the actual suprarenal twig is only an affluent. Into the conjoined parietal and suprarenal, before it flows into the renal vein, open two parallel ovarian veins (as in Marsupials), which thus cross over the left renal and do not open directly into it. The two lumbar veins posteriorly are single and symmetrical in their points of opening into the postcaval.

A dissection of two examples of *Crossarchus fasciatus* showed that the ovarian veins were disposed precisely as in *Galidia* and *Galidictis*. The renal veins were single.

In *Herpestes smithi* I found differences of detail which are worthy of record. The right and left spermatic veins had the same relations to the postcaval and left renal respectively as in the other Æluroid Carnivora already dealt with. The position

Text-fig. 130.



Postcaval vein and branches in *Suricata tetradactyla* (A, B) and *Cercoleptes caudivolvulus* (C).

Lettering as in text-fig. 129.

of the right vein was more like that which I have described here in *Suricata*. The renal veins were single, and the left suprarenal entered the postcaval independently of the left renal.

The lumbar veins were in some respects like those of *Galidia*, and in other respects differed. They resemble those of *Galidia* in the fact that there are two veins on each side, and that while those of the left side open separately into the postcaval those of the right side join before doing so. There is, however, this important difference between the two animals in respect of these veins. In *Herpestes* the postcaval has already divided into the two iliacs, into each of which therefore the lumbars really open. In *Galidia* the vein is a single vein at the points of entry of the lumbars, and does not divide until later. It should also be mentioned that the renals are asymmetrical with the asymmetry of *Galidia*. With this is associated the separate entry into the postcaval of the left suprarenal already mentioned. I say "associated," since in one specimen of *Crossarchus* where the left renal and the left suprarenal entered the postcaval separately, there was an asymmetry between the two renals; whereas in a second example, where the left renal and suprarenal entered the postcaval together, it was at a point exactly opposite to the entrance of the right renal.

I have also collected some notes on Viverrine Æluroids, and have already figured in *Genetta vulgaris* * the veins with which I am now dealing. In *Paradoxurus hermaphroditus* the two renal veins were asymmetrical, the right entering the postcaval above the left. The spermatic veins showed an exaggeration of the condition described above in *Suricata*. The left spermatic vein as usual enters the left renal; the right spermatic vein, as is also quite usual with Carnivora, enters the postcaval directly but very far forward—on a level, in fact, with the entrance of the left renal. The two lumbar veins are, as in *Genetta vulgaris*, single veins on each side. They enter the postcaval asymmetrically, and are asymmetrical in two ways. In the first place, the left vein enters rather more anteriorly than the right. In the second place, the right vein enters the postcaval after it has bifurcated to form the iliacs. The left vein enters the postcaval in its undivided region. It is to be noted that the corresponding arteries are also correspondingly asymmetrical in the position of their exits from the aorta. I found two examples of the African Civet Cat (*Viverra civetta*), both of them males, to differ slightly in the branches of the postcaval. In one the veins were exactly as I have described them in *Paradoxurus hermaphroditus*, except that the lumbars were quite symmetrical in position and that they both entered the postcaval before its bifurcation. In the other the right spermatic vein entered the postcaval some way behind the renals, and the lumbars, though symmetrical, were two on each side.

Of *Nandinia binotata* (text-fig. 129 B, p. 486) I have examined some of the veins with which I am concerned in the present communication in two individuals, both males. In one of these the

* P. Z. S. 1907, p. 812, text-fig. 214.

two renals were pretty symmetrical as to their point of entry into the postcaval. The left spermatic entered the left renal as usual, and the right spermatic entered the postcaval as usual some way further down. The second example showed a very remarkable variation—for the condition which I am about to describe must be, I think, a variation, though I possess no positive notes or sketches of anything similar in the first-described example*. In this specimen the suprarenal, renal, and spermatic veins were all separate from each other up to their entry into the postcaval vein, which they entered in the order named. The spermatic vein, however, was an unusually thick vein (for a spermatic vein), and bending backwards ran for some little way parallel to the postcaval, thus suggesting a persistent left cardinal vein. Presently it divided into two, the smaller continuing in the same straight line as a quite slender spermatic vein. The larger trunk bent round to the left, and after giving off some branches to the omentum ended in the spleen. There can be no possible doubt about the course of this vein: it was full of blood, and could be followed throughout with perfect ease. Furthermore, I do not think that any affluent from the spleen reached the portal system. All the blood thence derived flowed along the vein which I have just described. This, again, perhaps favours the supposition of the persistence of a left cardinal vein. On the other hand, this view is not supported by the position of the orifices of the lumbar veins. These veins, in fact, of both sides open into the postcaval. They are symmetrical, and there are two veins on each side, as in many of the other Carnivora already described in the present communication. Moreover, on the left side, and the left side only, the two veins were joined by an anastomosis as in *Galidia*.

I shall now give an account of these same veins in a number of genera of Arctoid Carnivora.

In *Procyon lotor* the renals arose symmetrically. The left infrarenal entered the postcaval independently of the left renal. The right ovarian vein entered the postcaval some way below the renals, into the left vein of which pair the left ovarian vein poured its contents. There is thus no difference from the arrangement met with in the majority of Æluroid Carnivores, except in the symmetry of the renals, which is not a very common character of the Æluroidea.

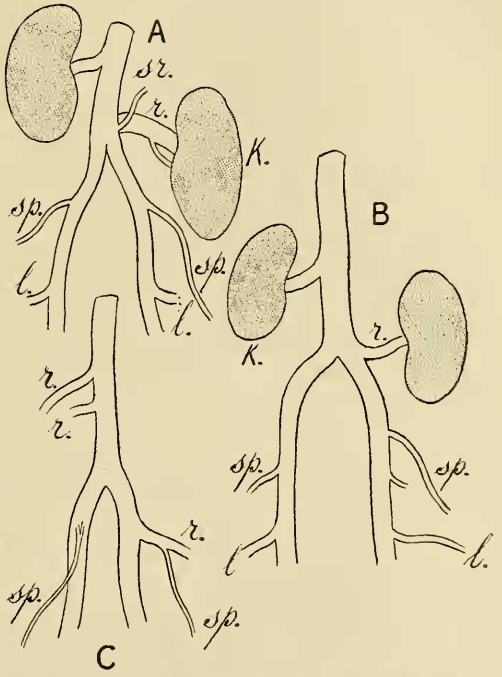
In *Cercoleptes caudivolvulus* (text-fig. 130 C, p. 488) there was the same symmetry of the renals; while the position of the ovarian veins was also the same as in *Procyon*. The left suprarenal joined the left renal just before the latter debouches into the postcaval. The lumbar veins were single and slightly asymmetrical, the left being in advance of the right. Each lumbar gives off a marked superficial branch running anteriorly dorsal to the

* In a specimen dissected subsequently (26. V. 9) there was no splenic vein opening into the postcaval.

kidney. Between the renals and the lumbars the postcaval received two intercostal veins.

I have examined four individuals of *Ictonyx capensis*—three of them females and one male—which showed certain individual differences. In one of them (text-fig. 131 B) the postcaval was double postrenally, after the fashion of the Armadillos and Anteaters *. The division was prolonged upwards to just anteriorly to the entrance of the left renal vein. The right rena vein entered the postcaval higher up, where it was a single vein.

Text-fig. 131.



Postcaval vein and branches in *Mellivora signata* (A), *Ictonyx capensis* (B), and *Mephitis mephitica* (C).

Lettering as in text-fig. 129.

The ovarian veins were symmetrical and arose each from its own separate postcaval. This was also the case with the lumbar veins, which were single veins. In the second female the conditions were of the more "normal" Carnivorous type. The renals were symmetrical, the postcaval was not divided, and the ovarian veins had the very asymmetrical origin found in nearly all Carnivora.

* Hochstetter, Morph. Jahrb. xx. 1893.

In a third, also a female, the renal veins were asymmetrical, but it was otherwise like the second specimen just described. The fourth example, a male, was just like the last specimen in all the veins the arrangement of which I studied.

I have preserved the skin of the "abnormal" example and am able to compare it with the skin of the second specimen which I have described and with two others. There are, however, no reasons for regarding the specimen as of a different species or race. It is certainly a good deal smaller, which may of course ultimately prove to be a racial or even specific character. But I am unable to press this conclusion at present.

Three examples of *Meles meles* differed among themselves. In one there was what I term the typical arrangement. In a second the left ovarian vein, instead of opening on to the renal, had moved down and debouched directly into the postcaval, but above the entrance of the right ovarian vein. In this example, moreover, the renals were symmetrical. In a third example the renals were also symmetrical. But in this specimen the orifice of the right ovarian vein had moved anteriorly and had come to open into the postcaval in common with the left ovarian.

In a female example of *Mephitis mephitica* (text-fig. 131 C, p. 491) I found a condition of the postcaval and its affluent veins almost exactly like that of the first specimen of *Ictonyx* of the series just described in one important particular, but differing in some other details. The point of resemblance between these in other respects closely allied Mustelines was the division of the postcaval vein postrenally. The division, however, in *Mephitis* is more marked than even in *Ictonyx*. It extends, in fact, further forward beyond the entrance of the left renal in *Mephitis*. Thus the left renal pours its blood into the left half of the postcaval, while the right renal communicates with the undivided anterior region of the postcaval. There are, however, two renals on the right side, though only one on the left. The ovarian veins arise symmetrically in relation to their position in the body, but asymmetrically in relation to the veins with which they are connected. The left-hand vein is as usual a branch of the left renal vein; the vein of the right opens as usual into the postcaval, but at a point exactly opposite to the entrance of the left renal and therefore from the right-hand subdivision of the postcaval. It is noteworthy that here, as in some other cases, the right ovarian vein is not a lateral affluent of the postcaval; it flows into that vein on its ventral surface.

In *Bassaricyon alleni*, the veins of which I have not referred to in my account of the general anatomy of this animal *, the dissection of a second specimen enables me to describe the disposition of the postcaval and its branches. The two renals are perfectly symmetrical and the ovarian veins are disposed in the usual asymmetrical fashion. The lumbar veins are double, but unite just

* P. Z. S. 1900, p. 661.

before entering the single postcaval; neither pair is connected by an anastomosis.

In three examples of *Nasua rufa* the branches of the postcaval were practically identical. In all of them the asymmetry of the renals was unusual, the left lying more anteriorly than the right. From the left arises, as usual, the left ovarian (or spermatic), while the right-hand vein enters the postcaval below this point.

In the Otter (*Lutra*) the renals were quite symmetrical and the ovarian veins quite as usual.

In *Helictis personata* the left ovarian vein was connected quite as usual with the left renal vein. But before entering it the ovarian vein received a small branch from the body-wall in the region of the kidney. This vein appears to me to be very possibly the equivalent of the second lower and smaller renal veins which I have figured in *Galidictis*. The right ovarian vein, as usual, communicates directly with the postcaval.

In *Ursus syriacus* the ovarian veins presented an arrangement which I have not found in other Carnivora. Both were directly connected with the corresponding renal vein. Nor were the renal veins symmetrical, as perhaps might be inferred from this fact. The right was in advance of the left, as is so commonly the case not only in the Order of the Carnivora but in Mammals generally.

It is hardly possible to extract from the foregoing series of facts any very plain cut-and-dried definitions of the several groups of Carnivora derived from the characters of the postcaval vein, such as is possible for example with the Marsupials. One can only point out tendencies to the development of a particular type in one group and of another type in another group of Carnivores. Thus it is the Arctoid Carnivora, and possibly chiefly the Musteline division of that group, in which the double postrenal postcaval vein is to be met with *. The Arctoid genera, in their wide distribution, nearly plantigrade feet, only at most slightly specialised carnassial teeth, and with their non-retractile claws, lie at a lower level than the Æluroidea. This result may be perhaps taken into consideration along with the condition of the postrenal section of the postcaval. In the same direction also points the more usual symmetry in the position of the renal veins; these very frequently, more frequently than in the Æluroidea, open into the postcaval opposite to each other. Again, it is more common in this subdivision of the Carnivora for asymmetry to be shown in the position of the spermatic or ovarian veins. No

* I am indebted to Mr. Burne for the information that in the Walrus the postcaval vein is double from the level of the renal veins. This observation was made upon the viscera of a young Walrus which died in the Society's Gardens, and was acquired by the Royal College of Surgeons. This condition in the Walrus is quite possibly normal, for Mr. Burne has directed my attention to the fact that Dr. Murie (Trans. Zool. Soc. vii. p. 431) found the vein double in the individual dissected by himself. This doubling of the postcaval behind the kidneys is not, however, distinctive of the Pinnipedia, for Murie figures (Trans. Zool. Soc. viii. p. 546, woodcut fig. 4) a single postcava in the Patagonian Sea-Lion.

absolute line of distinction can, it is true, be drawn between the Arctoidea and the Æluroidea in the arrangement of these veins. But whereas among the Æluroidea only a few forms (e. g., *Suricata*, *Herpestes smithi*) can be mentioned in which the veins are approximately symmetrical, there are more Arctoidea in which this symmetry occurs, viz. in the species *Mephitis mephitica*, *Ictonyx capensis*, *Ursus syriacus*. Moreover, in *Ursus* an absolutely "Marsupial" disposition of the spermatic veins is to be met with, where both are connected with the renal veins. Finally, the lumbar veins are more usually restricted to a single vein upon each side of the body in the Arctoidea; while they are prevalently double in the Æluroidea. That this feature is more archaic than that which characterises the Æluroidea can hardly be said. I merely dwell upon the fact that there is a tendency to the establishing of this difference between the two groups. But in dwelling upon these facts it must not be forgotten that some Arctoidea are apparently exactly like some Æluroids in the disposition of these veins.

Doubtless it cannot be said that the comparisons and contrasts amount to a great deal. But they have at least an interest in connection with the variations in the arrangement of the postcaval and its branches in the Common Cat, "*Felis domestica*." The veins of this animal have been lately studied in so large a number of specimens as 605 *. This large number probably gives some real idea of the range of variations in these veins. In no less than 23 examples the author found in the posterior region a double postcaval, such as I have described in *Ictonyx* and *Mephitis*. In 7 there was a left postcaval, instead of the normal Eutherian right. In others, again, the spermatic veins, instead of their normal asymmetry which is certainly the prevalent disposition in the Carnivora, as I have pointed out, both entered the postcaval directly.

§ *Other Blood-vessels.*

The *cerebral arteries* of *Galidia elegans* are like those of other Carnivora, differing only from those of certain forms in details. There is at the posterior end of the medulla a strongly marked rhomboid of arteries, as in many other Carnivora. This is associated with a large anterior spinal artery and vertebral arteries. The latter are single where they join the lateral angles of this rhomboid, and not double as they are in *Helictis personata* †. The middle cerebellar arteries are two on one side and one on the other (left); but the latter divides into two very shortly after its emergence from the basilar artery. It is to be noted that these

* W. Darrach, "Variations in the Postcava and its Tributaries, as observed in 605 Examples of the Domestic Cat," Amer. Journ. Anat. vol. vi. 1907, Anat. Rec. p. 30.

† Beddard, "On the Anatomy of *Helictis personata*," P. Z. S. 1905, p. 22, text-fig. 8.

arteries arise behind the sixth nerves. The anterior cerebellar arteries arise very shortly after the bifurcation of the basilar. Excepting for the fact that the cerebellar arteries are strictly paired, I found the arteries of the Common Otter precisely as has been just described for *Galidia*.

Dr. Tandler* has figured the cerebral arterial system of the Seal, and has represented the anterior spinal as of large size, as is the case with many Carnivora including those to which I have referred in the present communication. In a specimen of the Common Seal which I dissected some time since this was not the case. The anterior spinal was very slender, and communicated with the two very stout vertebrals by two very slender branches. The middle cerebral artery is single, and lies, as I have mentioned in *Galidia*, behind the origin of the sixth nerve †. The circle of Willis is joined anteriorly by the anterior communicating artery. I am unfortunately not quite certain about this part of the cerebral arterial system in *Galidia*; but I believe it to be like that of *Helictis* figured by myself ‡.

The system of cerebral arteries in an example of *Cryptoprocta ferox* may be compared with that of the types already described by others § as well as by myself. The first remarkable fact is the asymmetry of the arteries at the end of the medulla, which, however, is very possibly an individual peculiarity, as the asymmetry in the cerebral arteries of *Hyrax* described by myself ‖ proved to be later ¶. Both the anterior spinal and the vertebral arteries are stout. Although the main paired middle cerebellar artery lies behind the sixth nerve, there is a slender branch on the right side which lies in front of it. The anterior cerebellar artery lies just behind the bifurcation of the basilar. The arrangement of the anterior communicating artery and of the anterior cerebrals generally is very much as I have figured in *Viverra civetta***.

I do not think that the cerebral arterial system of *Hyæna crocuta* has been described. The specimen which I have had the opportunity of examining showed some differences from other Carnivora. Beginning as before with the posterior end of this arterial system, it is to be noted that the vertebral arteries are large—which is a general character of the group. On the other hand, there is no definite rhomboid-shaped arterial area at this point—*i. e.*, at the posterior end of the medulla—which is so characteristic of Carnivores. There are, in fact, two anterior spinal arteries, smaller than the vertebral, which run back at least for some little way without joining. I have no evidence, in fact, that they do ever join; for

* "Zur vergl. Anatomie der Kopfarterien bei den Mammalia," Denkschr. k. Akad. Wiss. Wien, Bd. lxvii. 1899.

† I have already (P. Z. S. 1904, vol. i. p. 191) directed attention to the varying position of these arteries with reference to the sixth nerve.

‡ P. Z. S. 1905, p. 22, text-fig. 8.

§ See also Bertha de Vriese, "Sur la Signification morphologique des Artères cérébrales," Arch. d. Biol. xxi. 1904, p. 357.

‖ P. Z. S. 1904, vol. i. p. 187, text-fig. 18.

¶ P. Z. S. 1909, p. 166.

** P. Z. S. 1904, vol. i. p. 194, text-fig. 21 B.

the brain was severed from the spinal cord some little way behind the medulla before I commenced its study. Into the circle of Willis the carotids enter rather far back; and in front of them, but still behind the sylvian artery, there was an ophthalmic artery, as I presume it to be, on the right side only: I found no trace of one on the left. A remarkable feature about the circle of Willis of this Hyæna is the great length of the anterior communicating artery, which lay in a loose circle posteriorly. Generally speaking, this artery is short and straight.

The *iliac arteries* in the specimen of *Galidia* were not symmetrical, as they are stated to be by Mivart * in other Æluroidea. The two larger external iliacs are produced by the terminal final bifurcation of the aorta. From the left of these arises a trunk which continues for a short distance in the same straight line as the aorta and then divides into the two internal iliacs. It is perhaps worth while mentioning that I found an asymmetry the precise converse of this in a Squirrel (*Sciurus prevosti*). In this animal the aorta ended in the same way, by dividing to form the two external iliacs. From the right of these arose a branch which shortly divided to form the two internal iliacs.

3. On the Postcaval Vein and its Branches in certain Mammals. By Frank E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 132–139.)

In studying the venous system of a large number of Mammals at the Prosectorium at the Zoological Society's Gardens I have relied entirely upon naturally injected veins. And indeed veins turgid with their own blood are better for this study than artificial injections. For, in the first place, error is absolutely eliminated, inasmuch as no injection-fluid can escape and give rise to apparent branches which have no existence; and, secondly, it is always possible to press upon the contained blood, and thus ascertain the reality of anastomoses, which can be readily missed in a defective artificial injection. Moreover, in animals which have died with their veins full of blood, minute branches which might be missed in other specimens, and which might not be reached by an artificial injection, are plainly revealed. I have, therefore, in the present communication only dealt with those out of the many specimens which I have dissected during many past years that were in a good condition for this particular study, and have rejected the data derived from anæmic examples. Thus I have every reason to believe that the facts which I now bring before the Society are accurate. It is now well known

* P. Z. S. 1882, p. 515.